



Design Knowledge & Reuse Management

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The Boeing Company
6 May 2003

Summary

- ✧ The Phantom Works and KARMA
- ✧ Definitions of Knowledge Management
- ✧ Why is it important?
- ✧ What are we doing at Boeing?
- ✧ What is the future of Standard Parts and Standardization?

Who is the Boeing Company ?

✦ The Boeing Company, with headquarters in Chicago, is the largest aerospace company in the world and the United States' leading exporter. It is the world's largest manufacturer of commercial jetliners and military aircraft, and the largest NASA contractor. The company's capabilities in aerospace also include rotorcraft, electronic and defense systems, missiles, rocket engines, launch vehicles, and advanced information and communication systems. The company has an extensive global reach with customers in 145 countries and manufacturing operations throughout the United States, Canada and Australia.



The Boeing Company Groups

Commercial Airplanes	World Headquarter s	Integrated Defense Systems
Connexion by Boeing	Shared Services	Air Traffic Management
Boeing Capital Corporation	Phantom Works	Washington DC Operations

Functional Process Councils cut across these organizations

The Phantom Works & KARMA

- ✦ The R&D arm of the Boeing Company

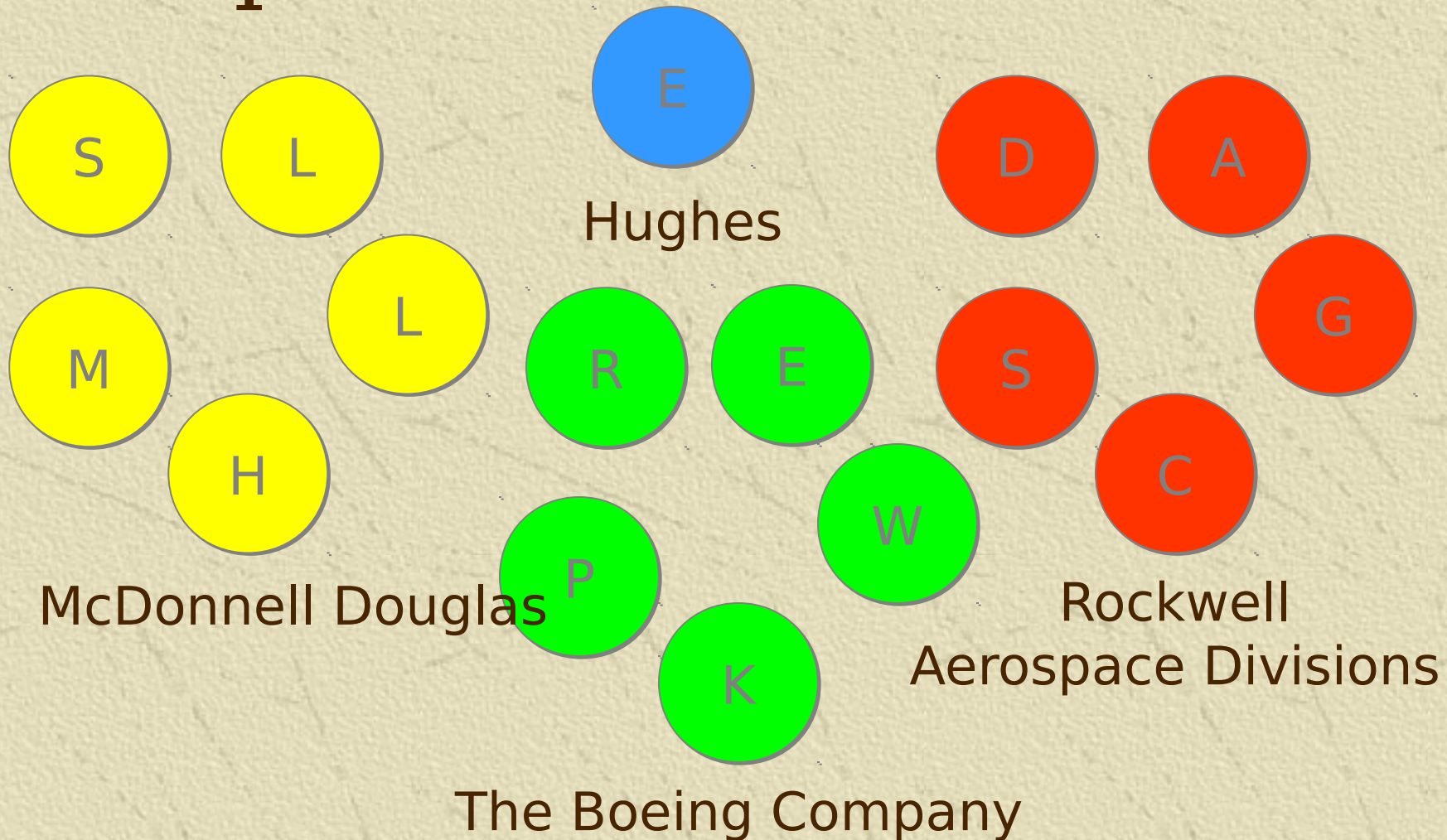
 - ◆ Capture new business

 - ◆ Common benefit Thrusts

- ✦ The Lean and Efficient Thrust

- ✦ The KARMA Project– Knowledge and Reuse Management

Mid-90s Mergers & Acquisitions



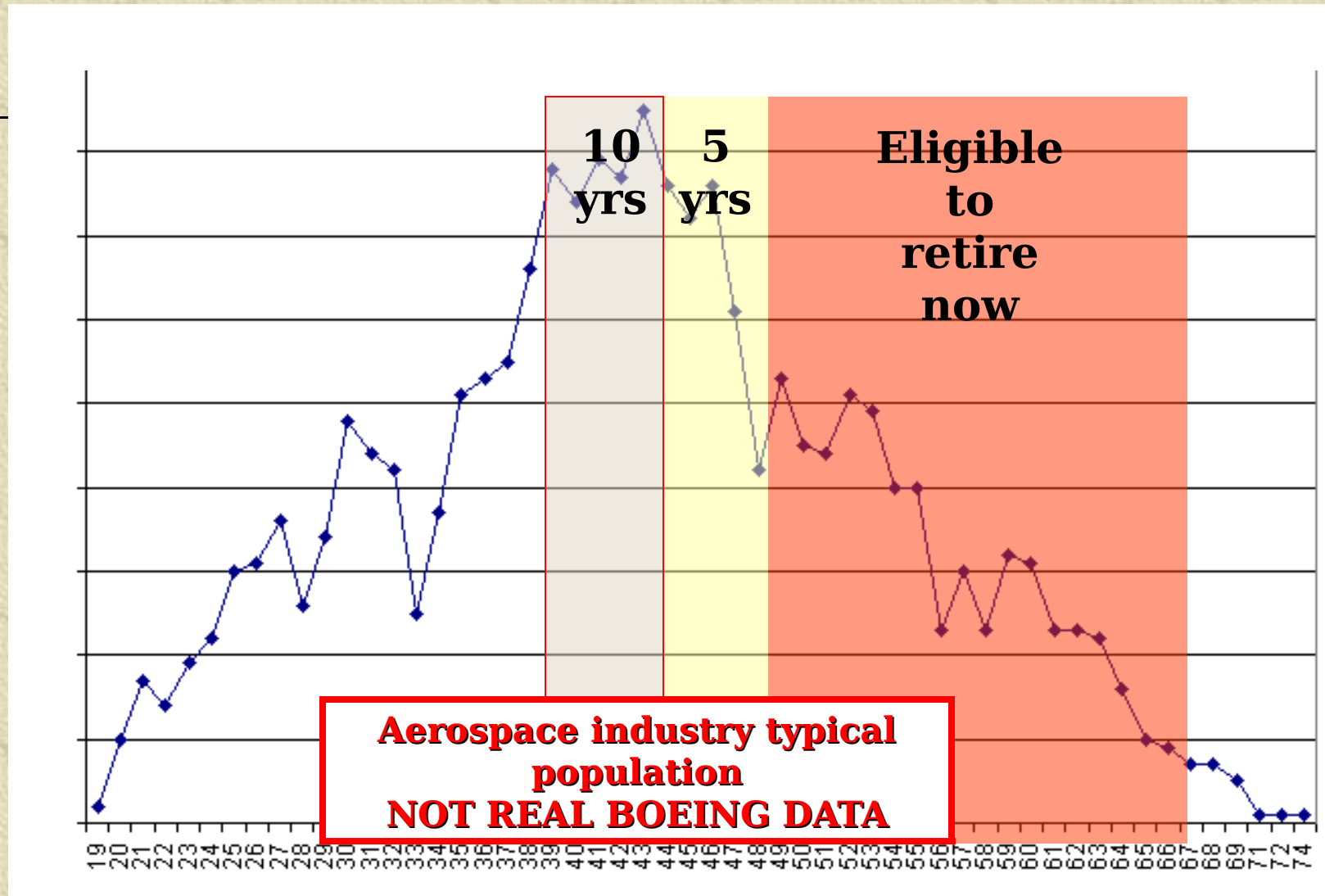
Some Definitions of KM

- ✦ Explicit Knowledge Management is the systematic process of finding, selecting, organizing, distilling and presenting information in a way that improves an employee's comprehension in a specific area of interest.
- ✦ Tacit Knowledge Management is the process of making collective insight, experience & expertise of the organization available to anyone within the organization, enabling accelerated learning & innovation for a competitive edge.

Why is KM Important?

- ✧ Pending Baby Boomer Retirements
- ✧ Virtual Organizations and Network-Centric Operations
- ✧ Extended Enterprise
- ✧ Reduce Risk
- ✧ Preserve Design Intent
- ✧ Life Cycle Savings for Design Reuse and Standardization

Age Demographics



KM is an Industry Issue

7-20% of employees time-on-job is spent **replicating existing solutions** for others



30% is the **bottom-line differential** for enterprises that proactively manage their **intellectual assets** over those that do not.



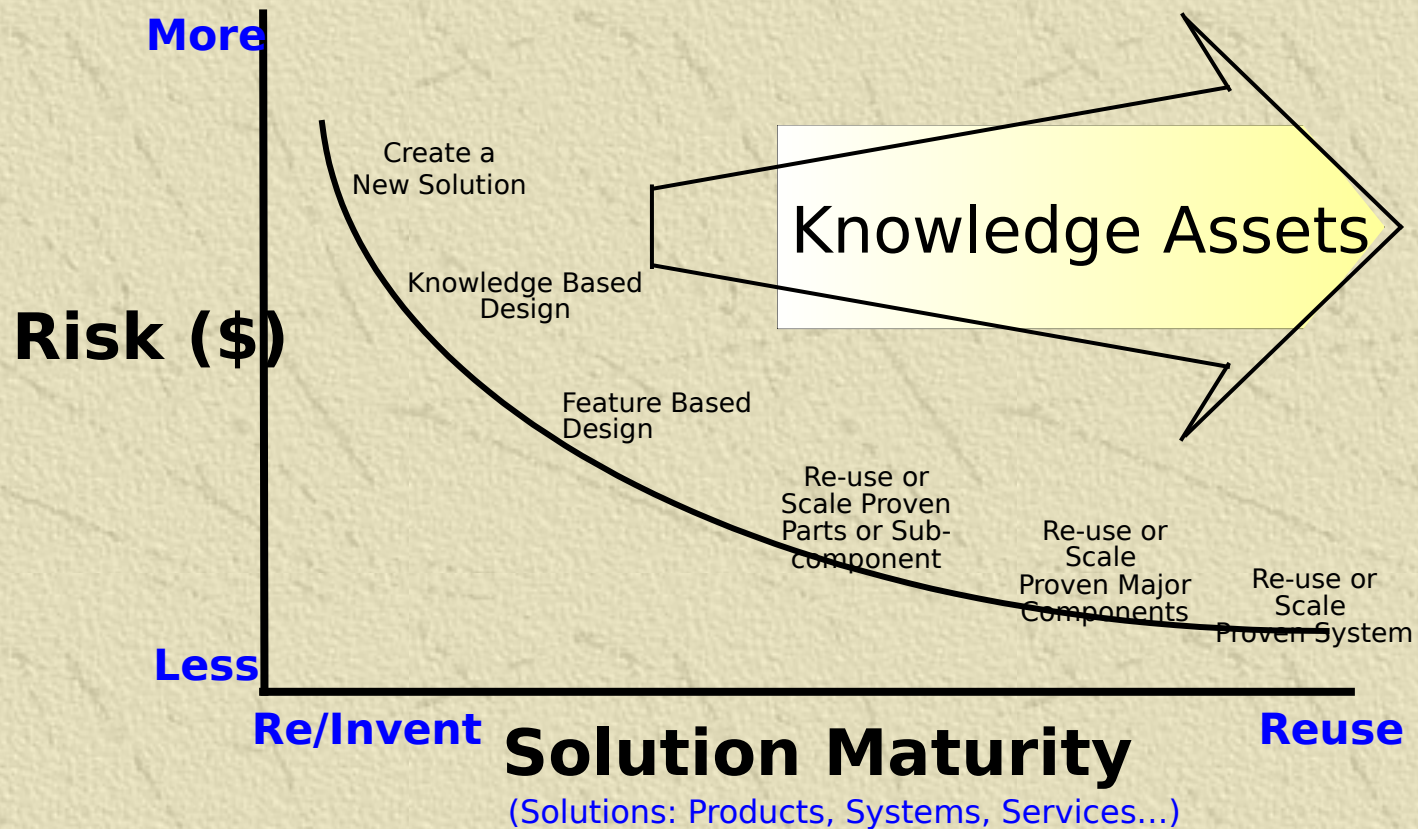
44% of employees report that their team is poor or very poor at **transferring knowledge** to its employees.



By 2003, average cost of redundant effort in Fortune 500 companies will reach \$5,850 per employee - per year.

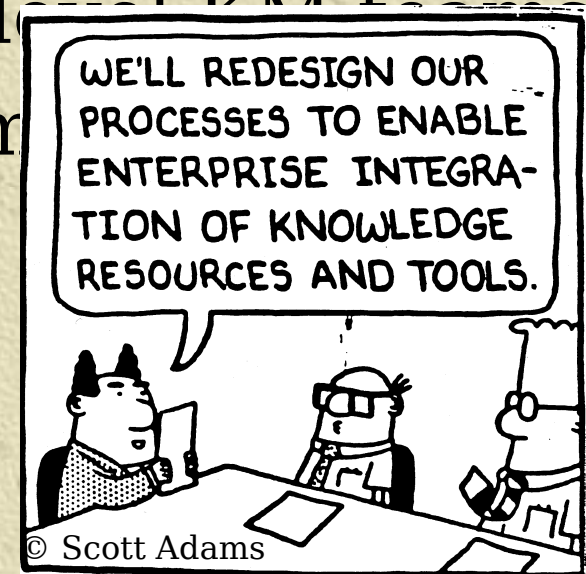


KM Reduces Risk



Formal KM Activities in Boeing

- ✧ KM Sub-team of the IS Process Council
- ✧ Enterprise KM Users Group
- ✧ Enterprise KM Community of Practice
- ✧ Various site/program-level KM teams
- ✧ IDS KM Portfolio Team
- ✧ PW KARMA Project



I Was KM Before KM Was Cool

- ✧ Libraries
- ✧ Mentoring
- ✧ Functional Teams and User Groups
- ✧ Learning/Training
- ✧ Collaboration
- ✧ Knowledge-Based Engineering
- ✧ Design Reuse
- ✧ Standardization

Design Reuse is a KM Issue

✦ All the Knowledge Associated with an Item is Already Bundled for Reuse

- Solid Model
- Physical Properties
- Price, Availability and Inventory are Known
- All Purchasing Data Streams Exist
- All Manufacturing Data Streams Exist
- Supplier and Raw Material Sourcing is Done

✦ New Knowledge Must be Placed into the Appropriate System for Downstream Leveraging

- ◆ Supplier Management, Tooling, Manufacturing
- ◆ Quality and the Next Designer/Program

Standardization is the Epitome of Design Reuse

Who Needs Standards?



We All Do!

Design Reuse Benefits

- Engineering design is only 10% of the total non-recurring cost

- Design retrieval & reuse can save 90% of non-recurring costs

- Engineering is only 5% of the total product cost

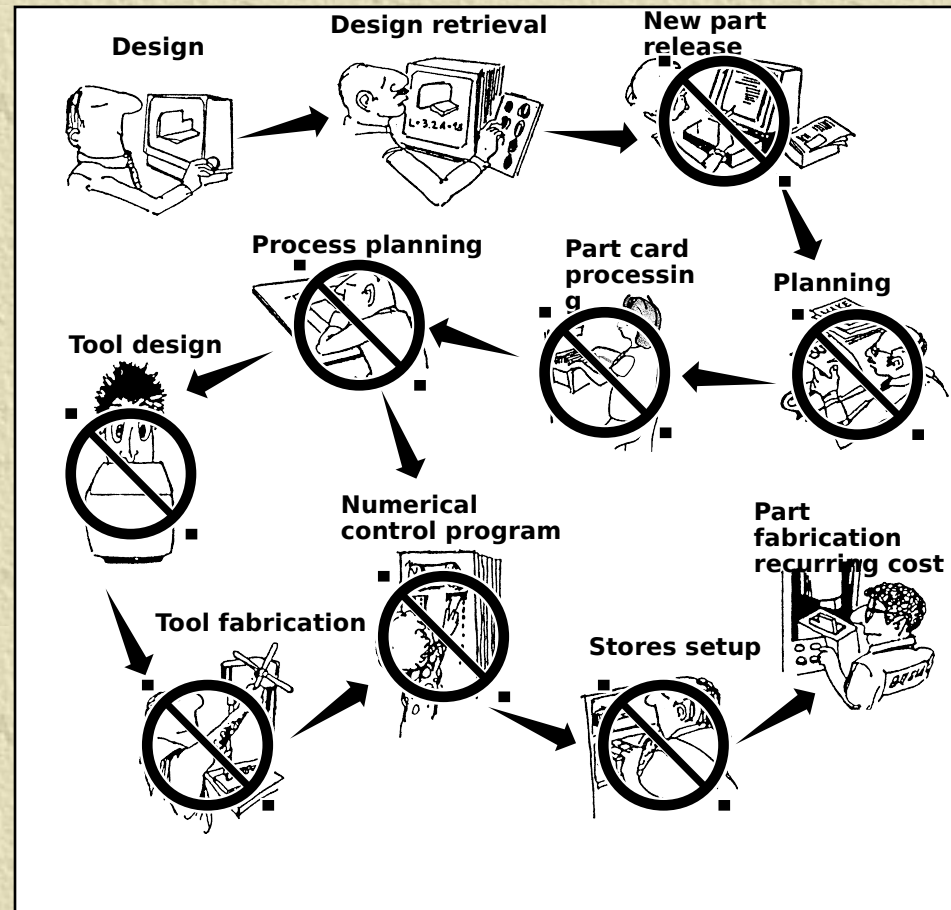
- Design Knowledge Reuse

- Reduces variability / improves Quality

- Eliminates many downstream activities and

- Increases procurement leverage

- Increases inventory



Design Reuse Opportunities

- ✧ Common Parts
- ✧ Common Materials
- ✧ Extrusions
- ✧ Small Design Parts
- ✧ Sub-systems
- ✧ Product Derivatives



Existing Boeing Searchable Database

Contents

- ✦ Standard Parts in CPIMS

 - ◆ 800,000

- ✦ Designed Details - NIRS

 - ◆ 1,000,000 and growing

- ✦ Extrusion Cross Section
SACADRE

 - ◆ 60,000



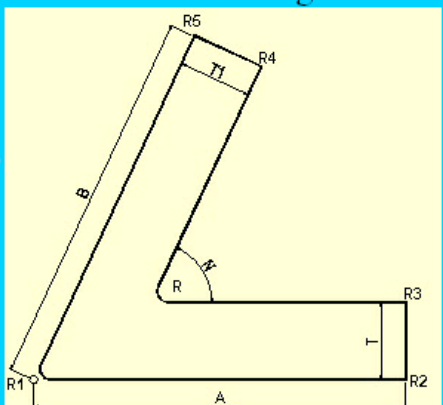
Extrusion Reuse Database

SACADRE Parametric Web Search - Netscape

File Edit View Go Communicator Help

Bookmarks Netsite: <http://catdev.web.boeing.com/cgi-bin/sacadre/psearch.pl?shape=EXANG> What's Related

Extruded Angle



Profile Search Criteria

Name	Lower Bound	Upper Bound	Name	Lower Bound	Upper Bound
A(IN)			B(IN)		
N(DEG)			T(IN)		
T1(IN)			R(IN)		
R1(IN)			R2(IN)		
R3(IN)			R4(IN)		

Search For Profiles

Select New Shape

Search Results

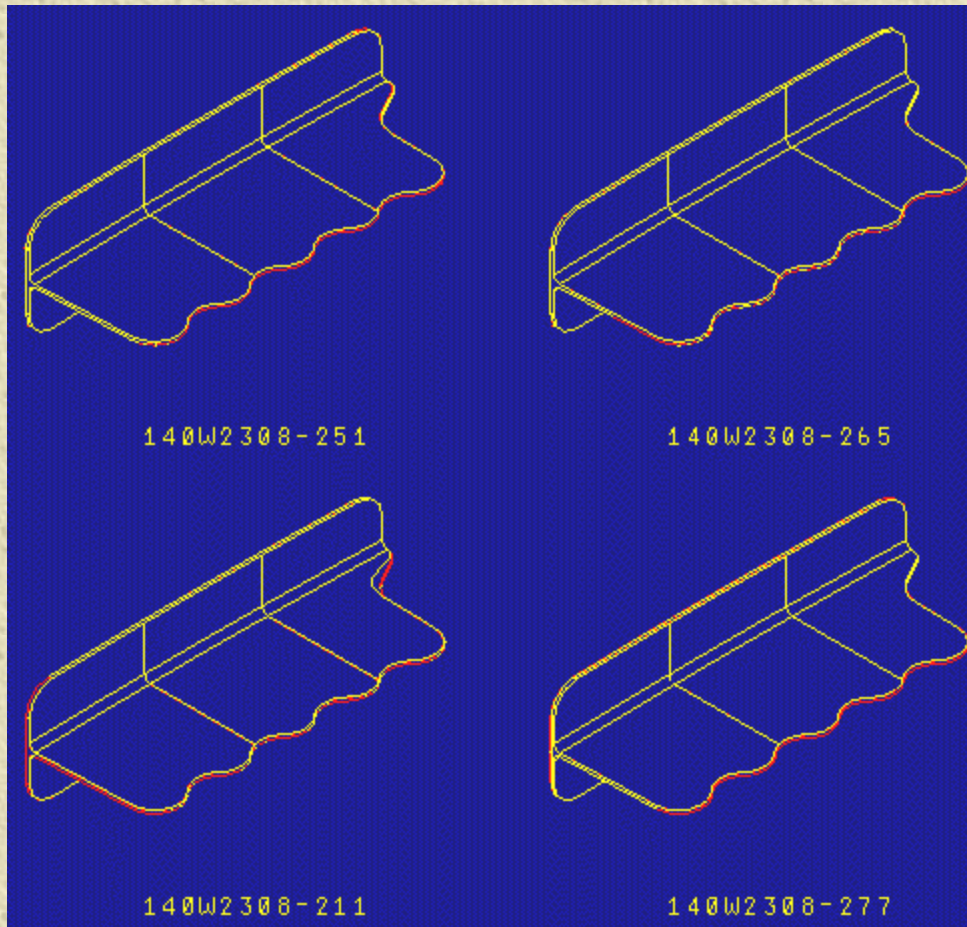
Total: 3115
Displayed: 1 - 15

Click on a profile number to

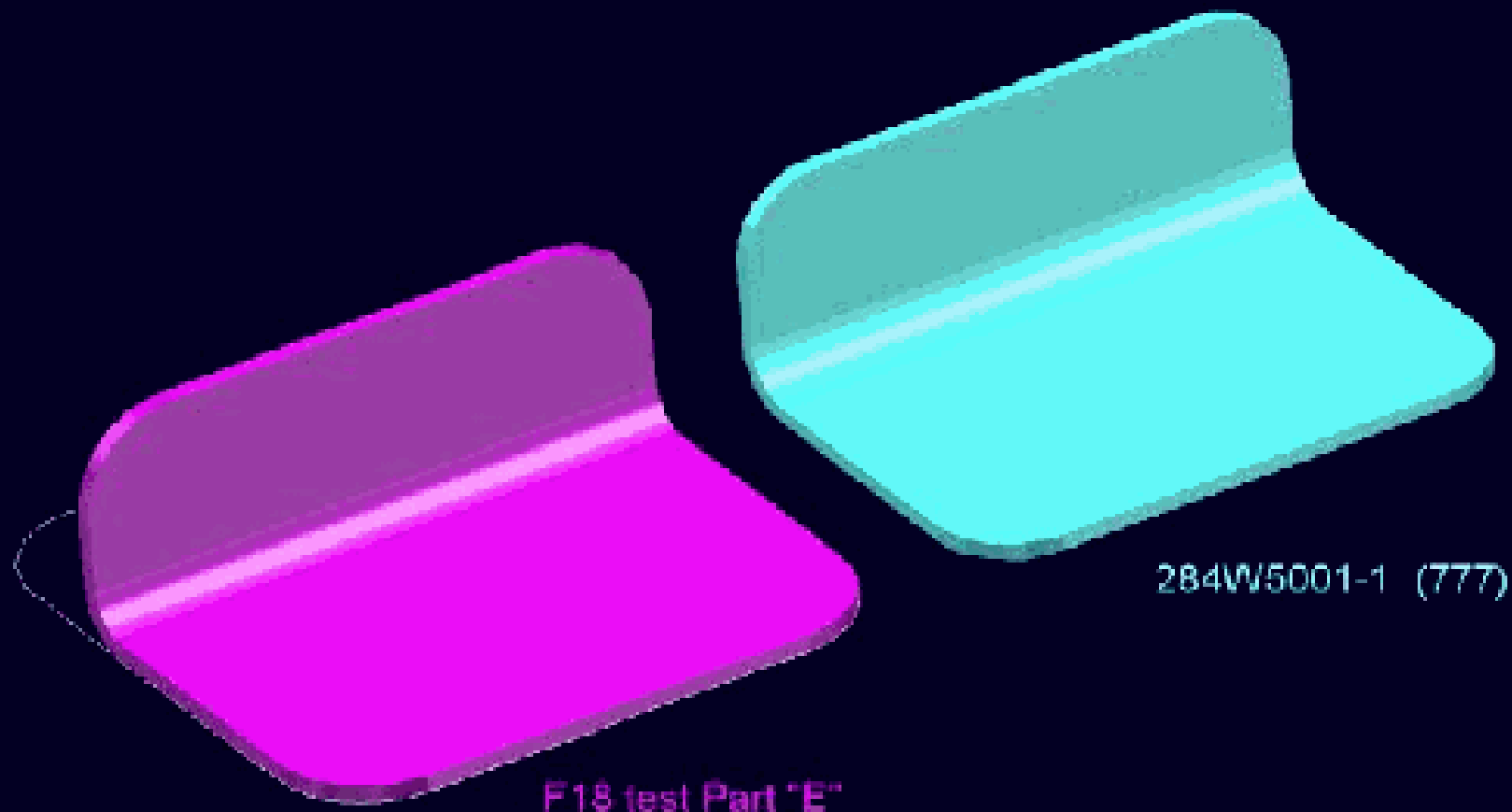
Profile Number	A	B	N	T	T1	R	R1	R2	R3	R4	R5
BAC1503-100828	2.900	1.600	90.000	0.050	0.050	0.090	0.000	0.000	0.050	0.050	0.000
BAC1503-100947	5.200	3.800	90.000	0.160	0.160	0.250	0.031	0.032	0.032	0.032	0.032
BAC1503-100948	3.800	1.425	90.000	0.125	0.200	0.250	0.031	0.031	0.031	0.031	0.031
BAC1503-100949	3.500	1.250	90.000	0.125	0.125	0.125	0.031	0.031	0.031	0.031	0.031
BAC1503-100950	1.800	1.250	90.000	0.125	0.420	0.120	0.031	0.031	0.031	0.031	0.031
BAC1514-2945	3.500	1.250	82.000	0.125	0.550	0.190	0.016	0.016	0.016	0.016	0.016
BAC1514-3042	6.500	2.500	68.220	0.200	0.125	0.250	0.375	0.031	0.031	0.031	0.031
BAC1514-3047	2.250	1.300	155.000	0.063	0.063	0.060	0.060	0.016	0.016	0.016	0.016
BAC1514-3048	1.400	1.180	126.000	0.450	0.090	0.250	0.016	0.016	0.016	0.016	0.016

Document: Done

Size/Shape-Driven Catalog of Designed Parts



**F18 test Part E and 777 detail part
"discovered" using TNIRS
(Transparent Neural Information Retrieval System)**



Multi-Use Brackets

Support Bracket



287W4128-53ATA



287W4128-66



287W4128-55ATA



287W4128-68



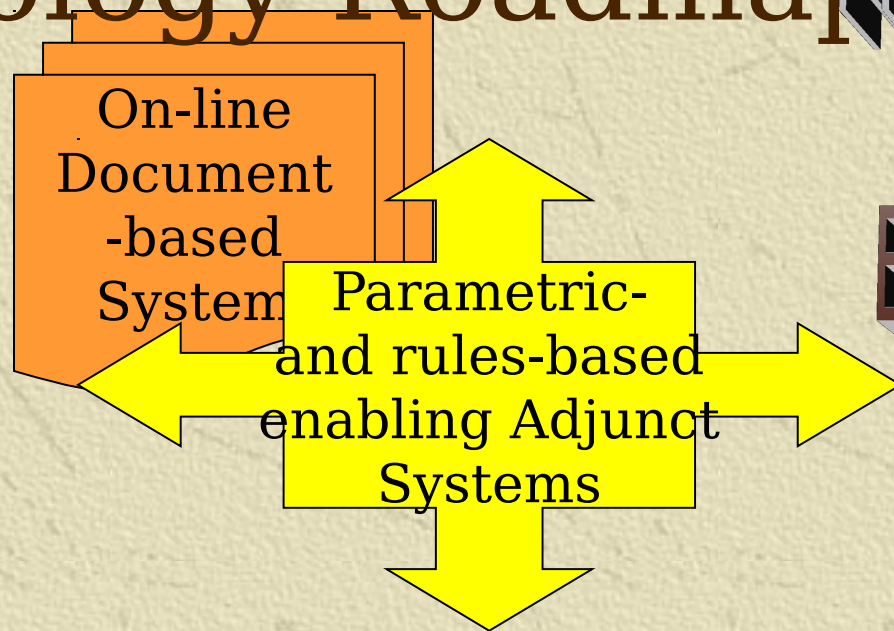
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Shims



Standards Data Management Technology Roadmap

Model-Based
Digital
Enterprise



Document
-based
Enterprise

1916

1990s

2010

The KARMA Project

- ✧ Knowledge Management
- ✧ Knowledge Based Engineering
- ✧ Design Reuse
- ✧ Program Parts Management
- ✧ Product Standards Support for Model Based Definition and the Digital



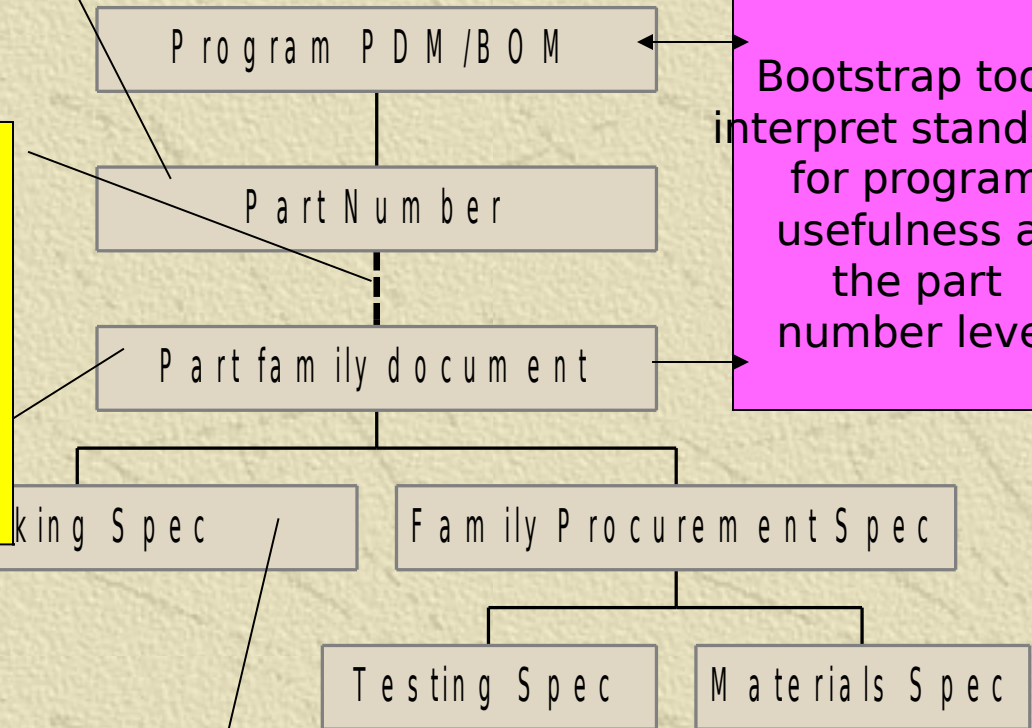
Document Enterprise: Standard Part Example

Program callout at this level.
Entered by hand usually twice
(assembly and BOM)

The part number ultimately is a
human interpretation of a meaning
given to options described by notes,
references to other documents and
rows and columns in tables.
Templates do not exist to assure
completeness, consistency or best
practices. 20% of the time, part
callouts have errors.

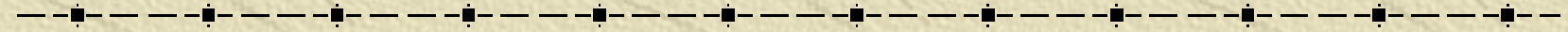
Configuration control at
this level. Using
programs are not
tracked or notified of

There is no process for monitoring the
release of changes for sub-tier specs or
understanding the impact on the documents
that refer to it. These documents exist in a
variety of Boeing owned and external
systems.

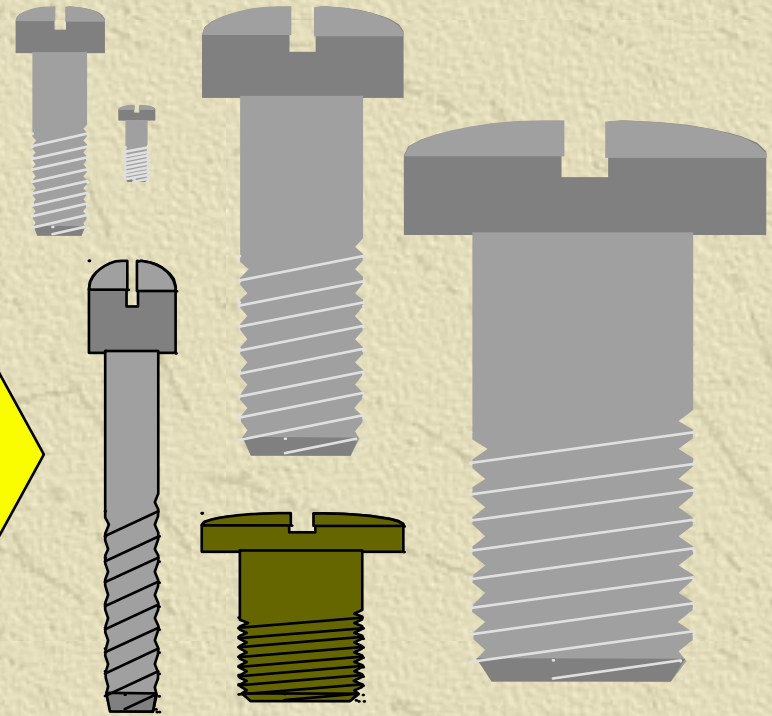
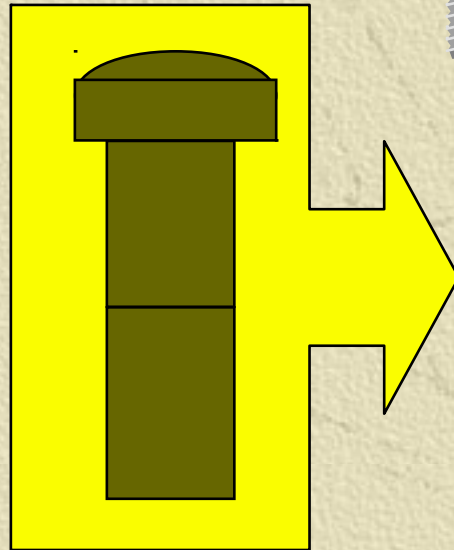


Bootstrap tools
interpret standards
for program
usefulness at
the part
number level

Solid CAD Model Creation

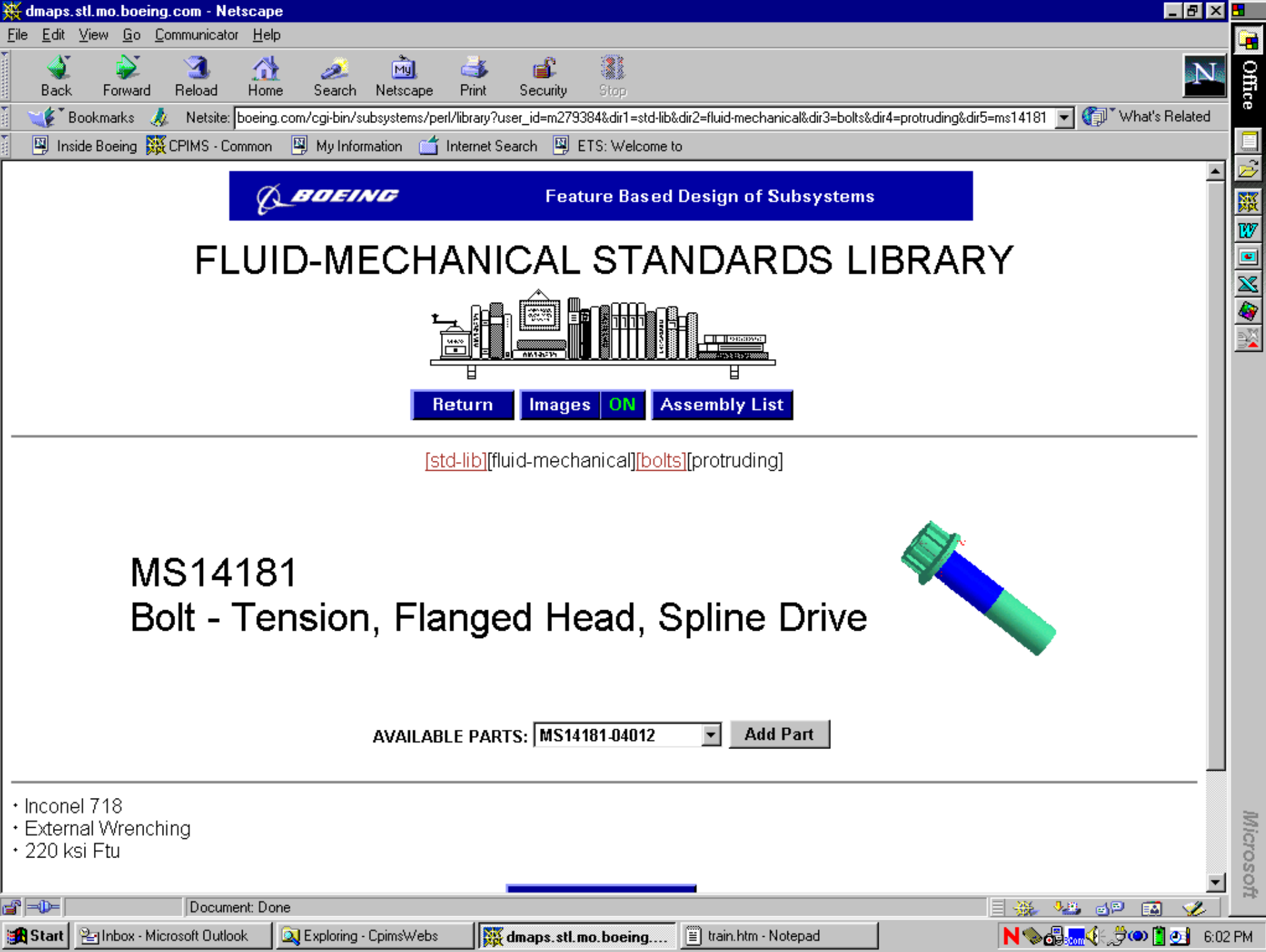


A	B	C
0.5	10	CRES
1	20	Al
1.5	30	Ti



Parametric Model Template
Data [CAD-system
unique]

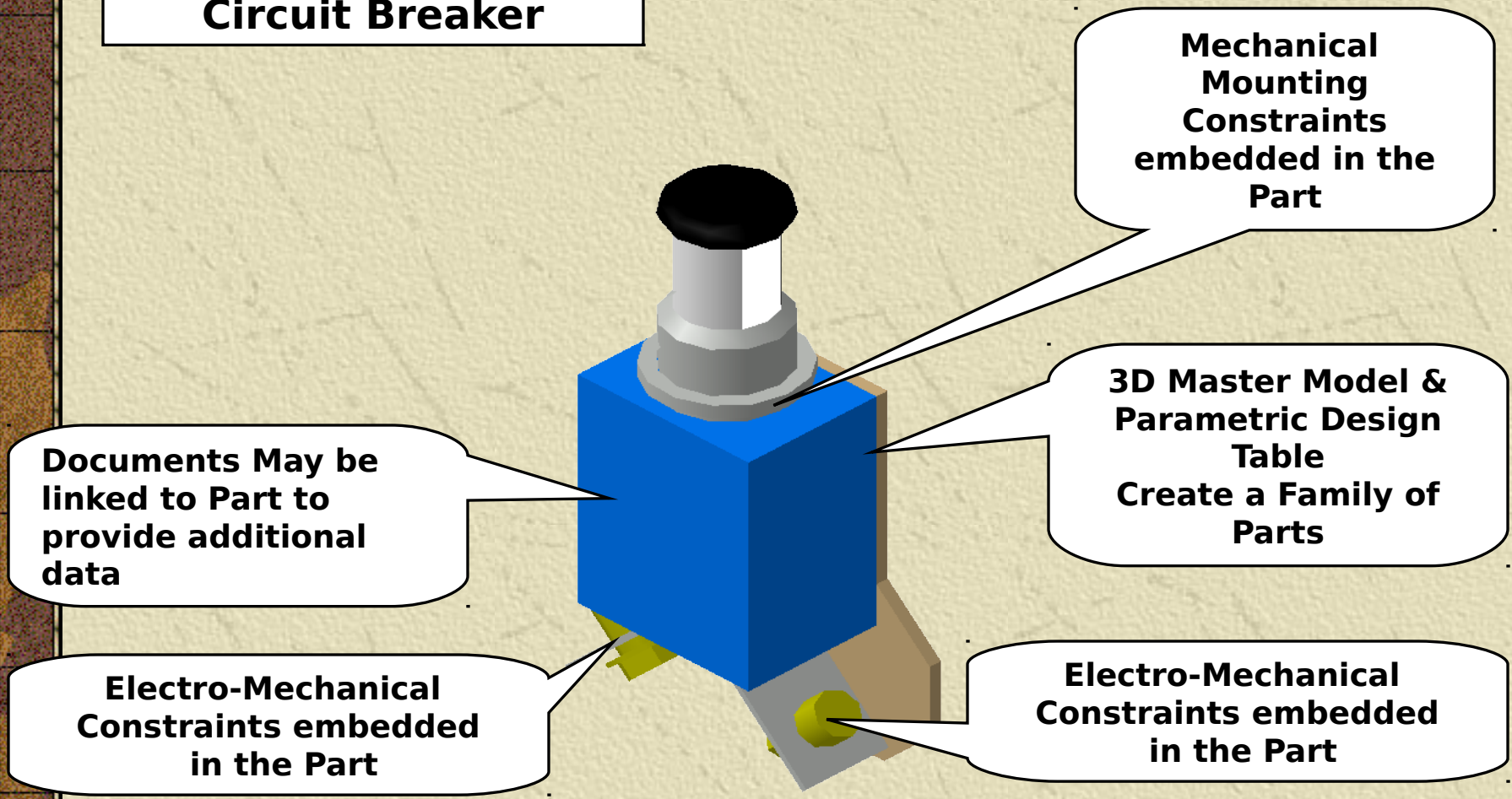
Models of Specific
Series, Sizes, and Features



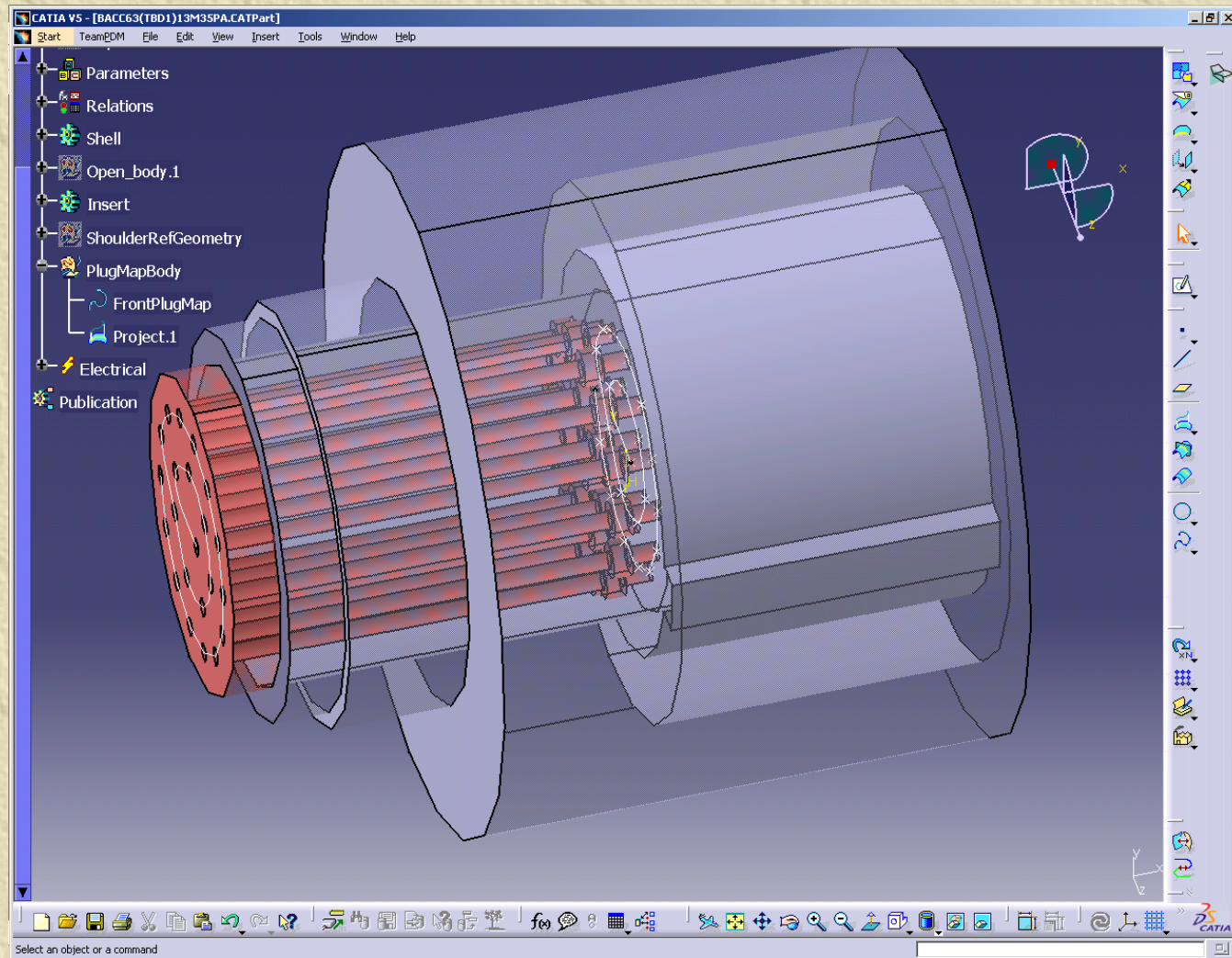
“Smart” Parts

The Part knows how to behave at every point of use

Circuit Breaker



Detailed Authoritative Part Models



Part Catalogs Promote Reuse

- ✦ Built into the Design tools environment
- ✦ Make it easy to select existing parts

Control new part introduction

Terminal Lugs

BACT12AR101	BACT12AR102	BACT12AR103
BACT12AR104	BACT12AR105	BACT12AR106
BACT12AR121	BACT12AR122	BACT12AR123

Receptacles

BACC45FN14-15P7	BACC45FN14-15SN	BACC45FN16-24P6
BACC45FN16D24SN	BACC45FN18-14SN	BACC45FN20-28S6
BACC45FN20-41P6	BACC45FN20-41PN	BACC45FN22-55PN



Possible Concept: Dynamic Preferred Part

- ## Factors
- ☑ Used at multiple sites or programs
 - ☑ Supportability/Reliability
 - ☑ Current or forecasted usage volume
 - ☑ Multiple sources for the part
 - ☑ Certified Supplier/ Gold-Silver-Bronze Rating
 - ☑ Diminishing Sources
 - ☑ Strategic or Sunset Technology
 - ☑ Environmentally/ HAZMAT friendly
 - ☑ Cost (including handling and installation costs)
 - ☑ Weight
 - ☑ Quality History
 - ☑ Existence of Specification
 - ☑ Priority of Specifications (mil, industry, corp., component-unique)

Questions?



 **BOEING®**
Forever New Frontiers

The image features a large, dark rectangular area containing a view of the Earth's horizon from space. The curve of the planet is visible, showing blue oceans and white clouds against the blackness of space. In the upper left corner of this dark area, the Boeing logo is displayed in white, consisting of a stylized 'B' inside a circle. To the right of the logo, the word 'BOEING' is written in a bold, sans-serif font, followed by a registered trademark symbol. Below this, the tagline 'Forever New Frontiers' is written in a smaller, italicized serif font. The entire slide is set against a light beige background with a subtle, cracked texture. On the left side, there is a vertical decorative bar with a grid pattern of brown and tan squares. Small black registration marks are visible at the corners of the dark rectangular area.